PATENT ABSTRACTS OF JAPAN

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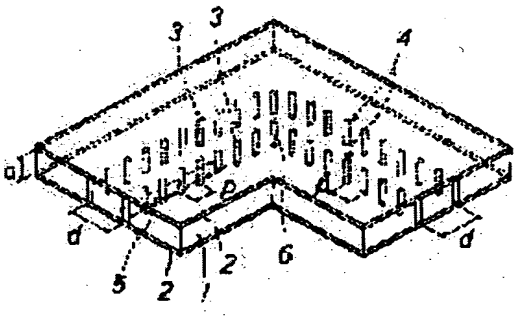
(71)Applicant : KYOCERA CORP

(72)Inventor : TAKENOSHITA TAKESHI
UCHIMURA HIROSHI

(54) DIELECTRIC WAVEGUIDE LINE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a dielectric waveguide line having high transmission characteristics which do not radiate nor leak electromagnetic waves of a high frequency signal even when a bent part exists in a transmission line and have reduced transmission losses.



SOLUTION: This waveguide line is provided with a pair of conductive layers 2 holding a dielectric substrate in-between, and two lines of through conductive groups 4 formed at a repetitive interval (p) less than a half of cutoff wavelength and fixed width (d). In the above structure, bent parts are formed on the two lines of the conductive groups 4, one line arranged on the bent part position is formed like a broken line having one through conductor 6 as a bent point, and the other line is formed like a circular arc having the fixed width (d) as a radius. Consequently the radiation of electromagnetic waves on the bent can be almost eliminated and a high frequency signal can be transmitted with a low transmission loss.

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CLAIMS

[Claim(s)]
[Claim 1] It is the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group. the following -- having -- the aforementioned conductor layer and the aforementioned penetration -- a conductor -- It breaks and is formed in the line. penetration of the two aforementioned train -- a conductor -- a group has a flection in the part and is located in this flection -- on the other hand, a train -- one penetration -- the conductor was made into the folding point -- the train of another side -- one aforementioned penetration -- a center [conductor] -- carrying out -- the above -- the dielectric-waveguide track characterized by the thing which make fixed width of face a radius, and which is formed circularly The conductor layer of the couple which pinches a dielectric substrate penetration of two trains formed so that it might be 1/2 or less repeat interval of the cutoff wave length of the aforementioned RF signal in the transmission direction of a RF signal and between the aforementioned conductor layers might be electrically connected in the aforementioned transmission direction and the direction which intersects perpendicularly by fixed width of face -- a conductor -- a group
[Claim 2] It is the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group. the following -- having -- the aforementioned conductor layer and the aforementioned penetration -- a conductor -- It breaks and is formed in the line. penetration of the two aforementioned train -- a conductor -- a group has a flection in the part and is located in this flection -- on the other hand, a train -- one penetration -- the conductor was made into the folding point -- The train of another side is a dielectric-waveguide track characterized by being formed in the shape of [corresponding to the base of the isosceles triangle which makes a vertex the aforementioned folding point of aforementioned one train, and makes width of face of the aforementioned regularity height] the polygonal line. The conductor layer of the couple which pinches a dielectric substrate penetration of two trains formed so that it might be 1/2 or less repeat interval of the cutoff wave length of the aforementioned RF signal in the transmission direction of a RF signal and between the aforementioned conductor layers might be electrically connected in the aforementioned transmission direction and the direction which intersects perpendicularly by fixed width of face -- a conductor -- a group
[Claim 3] The dielectric-waveguide track characterized by providing the following The conductor layer of the couple which pinches a dielectric substrate In the transmission direction of a RF signal, at intervals of 1/2 or less repeat of the cutoff wave length of the aforementioned RF signal A group is provided. and penetration of two trains formed so that between the aforementioned conductor layers might be electrically connected in the aforementioned transmission direction and the direction which intersects perpendicularly by fixed width of face -- a conductor -- the aforementioned conductor layer and the aforementioned penetration -- a conductor -- the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group -- it is -- penetration of the two aforementioned train -- a conductor -- the flection by which, as for the group, each of that train was arranged by the concentric circle arc

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the dielectric-waveguide track for transmitting RF signals, such as a microwave band and a millimeter wave band.
[0002]
[Description of the Prior Art] If it is called for that it is small to the transmission line for transmitting a RF signal in the RF circuit handling RF signals, such as a microwave band and a millimeter wave band, and transmission loss is small and it can form on the substrate which constitutes especially a circuit, or in a substrate, the strip line, a microstrip line, a coplanar track, a dielectric-waveguide track, etc. will have been conventionally used as such the transmission line from the bird clapper as it is advantageous in respect of a miniaturization.
[0003] Among these, although the strip line, the microstrip line, and the coplanar track consist of a dielectric substrate, a signal-line way which consists of a conductor layer, and a grand conductor layer, the electromagnetic wave of a RF signal spreads the inside of a signal-line way, the space around a grand conductor layer, and a dielectric, and these tracks are satisfactory to the signal transmission to a 30GHz band, above 30GHz, it is easy to produce transmission loss.
[0004] On the other hand, also in the millimeter wave band 30GHz or more, it is advantageous at the point that transmission loss is small, and, as for the waveguide type track, the track which can be formed in a multilayer substrate is also proposed taking advantage of the transmission characteristic which was excellent in such a waveguide.
[0005] For example, in JP,6-53711,A, a dielectric substrate is pinched by the conductor layer of a couple, and the waveguide track which formed the side attachment wall by two or more beer halls of two trains which connect between conductor layers further is proposed. the false conductor [according to this waveguide track] according the four way type of dielectric materials to a conductor layer and a beer hall -- surrounding with a wall -- a conductor -- Kabeuchi's field is made into the track for signal transmissions, composition becomes very easy, and the miniaturization of the whole equipment can also be attained
[0006]
[Problem(s) to be Solved by the Invention] Generally, when it constitutes a RF circuit, preparing a flection in the wiring circuit of the transmission line is not avoided in many cases.
[0007] however, the false conductor according [on a dielectric-waveguide track which was proposed by JP,6-53711,A, and] to the conductor layer of the couple, and the beer hall of two trains -- when a flection was simply prepared in the track for signal transmissions surrounded with the wall, since disorder arose in electromagnetic field, there was a trouble that transmission loss became large
[0008] It is in this invention being thought out in view of the above-mentioned situation, and the purpose offering the dielectric-waveguide track which there are not radiation and disclosure of the electromagnetic wave of a RF signal even if a flection exists in the transmission line, and has a good transmission characteristic with small transmission loss.

[0009]
[Means for Solving the Problem] As a result of repeating examination to the above-mentioned trouble, this invention person etc. about a dielectric-waveguide track By making the array of the beer hall of the beer hall group of two trains into predetermined array structure in the flection which prepared the upper and lower sides of the beer hall group of two trains established into the dielectric substrate in the transmission line of the structure which covers completely and is formed by these beer hall group and the conductor layer of the couple which flowed electrically Even if a flection exists in the transmission line, radiation and disclosure of the electromagnetic wave of a RF signal are not almost, and it found out that it could do with the good transmission characteristic of low transmission loss.
[0010] The dielectric-waveguide track of this invention is 1/2 or less repeat interval of the cutoff wave length of the aforementioned RF signal in the conductor layer of the couple which pinches a dielectric substrate, and the transmission direction of a RF signal. A group is provided. and penetration of two trains formed so that between the aforementioned conductor layers might be electrically connected in the aforementioned transmission direction and the direction which intersects perpendicularly by fixed width of face -- a conductor -- It is the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group. the aforementioned conductor layer and the aforementioned penetration -- a conductor -- It breaks and is formed in the line. penetration of the two aforementioned train -- a conductor -- a group has a flection in the part and is located in this flection -- on the other hand, a train -- one penetration -- the conductor was made into the folding point -- the train of another side -- one aforementioned penetration -- a center [conductor] -- carrying out -- the above -- it is characterized by the thing which make fixed width of face a radius and which is formed circularly
[0011] Moreover, the dielectric-waveguide track of this invention is 1/2 or less repeat interval of the cutoff wave length of the aforementioned RF signal in the conductor layer of the couple which pinches a dielectric substrate, and the transmission direction of a RF signal. A group is provided. and penetration of two trains formed so that between the aforementioned conductor layers might be electrically connected in the aforementioned transmission direction and the direction which intersects perpendicularly by fixed width of face -- a conductor -- It is the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group. the aforementioned conductor layer and the aforementioned penetration -- a conductor -- It breaks and is formed in the line. penetration of the two aforementioned train -- a conductor -- a group has a flection in the part and is located in this flection -- on the other hand, a train -- one penetration -- the conductor was made into the folding point -- It is characterized by forming the train of another side in the shape of [corresponding to the base of the isosceles triangle which makes a vertex the aforementioned folding point of aforementioned one train, and makes width of face of the aforementioned regularity height] the polygonal line.
[0012] Moreover, the dielectric-waveguide track of this invention is 1/2 or less repeat interval of the cutoff wave length of the aforementioned RF signal in the conductor layer of the couple which pinches a dielectric substrate, and the transmission direction of a RF signal. A group is provided. and penetration of two trains formed so that between the aforementioned conductor layers might be electrically connected in the aforementioned transmission direction and the direction which intersects perpendicularly by fixed width of face -- a conductor -- the aforementioned conductor layer and the aforementioned penetration -- a conductor -- the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group -- it is -- penetration of the two aforementioned train -- a conductor -- a group is characterized by having the flection by which each of that train was arranged by the concentric circle arc
[0013] According to the dielectric-waveguide track of this invention, in the conductor layer of the couple which pinches a dielectric substrate, and the transmission direction of a RF signal at intervals of 1/2 or less repeat of the cutoff wave length of the aforementioned RF signal and penetration of two trains formed so that between the aforementioned conductor layers might be electrically connected in the aforementioned transmission direction and the direction which intersects perpendicularly by fixed width of face -- a conductor -- from providing a group these conductor layers and penetration -- a conductor -- a group -- a false conductor respectively parallel to the Eth page to the Eth page and H plane of a

dielectric waveguide, or an H plane -- the portion which hits a wall is formed Therefore, the transmission line for RF signals which has the property which was similar to the dielectric waveguide by the flat sheet structure using the dielectric substrate can be obtained.
[0014] and -- according to the dielectric-waveguide track of this invention -- wiring of the transmission line -- setting -- a flection -- preparing -- facing -- penetration of two trains -- a conductor -- by arranging a group in the aforementioned specific structure, there is almost no radiation of the electromagnetic wave in a flection, and transmission loss has a small good transmission characteristic
[0015]
[Embodiments of the Invention] Hereafter, this invention is explained, referring to a drawing. Drawing 1 and drawing 2 are an outline perspective diagram for explaining an example of the gestalt of operation of the dielectric-waveguide track of this invention, respectively, and its plan. The conductor layer of the couple to which 1 pinches a dielectric substrate and 2 pinches the dielectric substrate 1 in these drawings, It is a conductor and 4 is 1/2 or less repeat interval p of the cutoff wave length of the RF signal in the transmission direction of a RF signal. the penetration formed as between the conductor layers 2 of a couple electrically connected in 3 -- and the width of face d fixed in the transmission direction and the direction which intersects perpendicularly -- penetration -- penetration of two trains formed by arranging a conductor 3 -- a conductor -- it is a group
[0016] According to drawing 1 , the conductor layer 2-2 of a couple is formed in the position which pinches the plate-like dielectric substrate 1 of predetermined thickness a. The conductor layer 2-2 is formed in the vertical side of the dielectric substrate 1 which faces across a transmission-line formation position at least. moreover, the penetration which connects between conductor layers 2.2 electrically between conductor layers 2.2 -- many conductors 3 are formed these penetration -- the penetration which is 1/2 or less predetermined repeat interval p of the cutoff wave length of the RF signal transmitted in the transmission direction, i.e., track formation direction, of a RF signal by this track, and serves as the transmission line by being formed in the aforementioned transmission direction and the direction which intersects perpendicularly with the predetermined, fixed interval (width of face) d at two trains as a conductor 3 is shown in drawing 1 and drawing 2 -- a conductor -- the group 4 is formed
[0017] since a TEM wave can be spread between the conductor layers 2.2 of the couple arranged in parallel -- penetration -- a conductor -- the penetration in each train of a group 4 -- when the interval p of a conductor 3 is larger than 1/2 of a cutoff wave length, it stops spreading along with the false waveguide made here, even if it supplies electric power to this track in an electromagnetic wave however, penetration -- with the interval p of a conductor 3 being 1/2 or less [of a cutoff wave length], an electric side attachment wall can be formed and an electromagnetic wave cannot be perpendicularly spread to the transmission line, but it will be spread in the direction of the transmission line, reflecting consequently, the conductor layer 2 of such structure and penetration -- a conductor -- the good transmission characteristic to which the cross section surrounded by the group 4 was very well similar with the dielectric waveguide with the field of the size of axd is acquired
[0018] It is good to consider as about 1/2 and a double-precision grade to the width of face d of the aforementioned regularity, in using by the single mode, although there is especially no limit to thickness a of the dielectric substrate 1 here. the portion which is equivalent to the H plane of a dielectric waveguide, and the Eth page in the example of drawing 1 -- the each conductor layer 2 and penetration -- a conductor -- the portion which is formed by the group 4 and is equivalent to a double-precision grade, then the Eth page and H plane of a dielectric waveguide about thickness a to width of face d -- the each conductor layer 2 and penetration -- a conductor -- it will be formed by the group 4
[0019] 5 [in addition,] -- penetration -- a conductor -- the penetration which forms each train of a group 4 -- a conductor -- it is the auxiliary conductor layer which connects three comrades electrically, and is suitably formed of a request moreover -- the example of this drawing 1 and drawing 2 -- penetration -- a conductor -- although the group 4 was formed in two trains -- this penetration -- a conductor -- a group 4 -- four trains or six trains -- arranging -- penetration -- a conductor -- the false conductor by the group 4 -- forming a wall in three-fold [a duplex and] -- a conductor -- the leakage of the electromagnetic wave from a wall can also be prevented more effectively

[0020] According to such waveguide track structure, it is epsilonr about the specific inductive capacity of the dielectric substrate 1. When it carries out, waveguide size is 1/epsilonr 1/2 of the usual waveguide. It becomes a size. Therefore, waveguide size can be made small and it becomes the size which can be used as the transmission line of the multilayer-interconnection substrate or the package for semiconductor device receipt in which wiring is formed with high density, so that material which constitutes the dielectric substrate 1 is made into what has large specific inductive capacity.
[0021] moreover, the penetration whose dielectric-waveguide track of this invention is the transmission line as shown in drawing 1 and drawing 2 -- a conductor -- it has a flection in a part of group 4, and it is located inside this flection -- on the other hand, a train -- one penetration -- the train of another side which made the conductor 6 the folding point and which breaks, is formed in the line and located outside -- this one penetration -- it is characterized by the thing which center on a conductor 6 and which is formed circularly Such a flection consists of structures as shown in drawing 2 .
[0022] The group 4 is arranged. the width of face of the track which intersects perpendicularly in the transmission direction of a RF signal in a flection turns into the fixed width of face d as indicated by drawing 2 -- as -- penetration -- a conductor -- A conductor 3 is arranged. the penetration located inside a flection -- a conductor -- the train of a group 4 -- one penetration -- the conductor 6 was made into the folding point -- it breaks and becomes a line -- as -- penetration -- on the other hand, the penetration located in the outside of a flection -- a conductor -- one penetration whose train of a group 4 is a folding point of a train which hits inside a flection -- it is arranged so that the radii of a radius d may be drawn focusing on a conductor 6
[0023] in addition, penetration -- a conductor -- the penetration which constitutes a group 4 -- the conductor 3 is arranged as mentioned above at intervals of [p] 1/2 or less repeat of a cutoff wave length, and although considering as a fixed repeat interval is desirable as for this repeat interval p in order to realize a good transmission characteristic, if it is 1/2 or less interval of a cutoff wave length, it cannot be overemphasized that it may be made to change suitably or some values may be combined therefore, the penetration which is equivalent to the outside of a flection -- a conductor -- the penetration which constitutes the train of a group 4 -- although considering as a fixed value is desirable in order for the repeat interval p of a conductor 3 to fully suppress radiation of an electromagnetic wave and to realize a good transmission characteristic, you may make it change variously with 1/2 or less value of a cutoff wave length similarly
[0024] Although it does not divide and limit if it has the property which functions as a dielectric and does not bar transmission of a RF signal as a dielectric substrate 1 in this invention, the dielectric substrate 1 from the point of the precision at the time of forming the transmission line and the ease of manufacture has ceramics to a desirable bird clapper.
[0025] Although ceramics with specific inductive capacity various until now as such ceramics are known, in order to transmit a RF signal on the waveguide track of this invention, it is desirable that they are paraelectrics. Generally this is because as for ferroelectric ceramics dielectric loss becomes large in a RF field and transmission loss becomes large. Therefore, specific-inductive-capacity epsilonr of the dielectric substrate 1 4-100 A grade is suitable.
[0026] Moreover, for the line breadth of the wiring layer generally formed in a multilayer-interconnection substrate or the package for semiconductor device receipt, specific inductive capacity since it is 1mm at the maximum is 100. When it uses so that the upper part may become the electromagnetic-field distribution which an H plane, i.e., a magnetic field, rolls in parallel with an upper field using material, the minimum frequency which can be used is computed with 15GHz, and use of it is attained also in the field of a microwave band. The dielectric which consists of a resin generally used as a dielectric substrate 1 on the other hand is specific-inductive-capacity epsilonr. Since it is about two, when line breadth is 1mm, it cannot use, unless it is more than about 100 GHz.
[0027] Moreover, although there is much what has a very small dielectric dissipation factor in such paraelectrics ceramics like an alumina silica, all paraelectrics ceramics cannot be used. In the case of a dielectric-waveguide track, the loss by the conductor is not almost, most losses at the time of a signal transmission are losses by the dielectric, and the loss alpha by the dielectric (dB/m) is expressed as

follows.
alpha -- the inside of =27.3xtan delta/lambda / {1-(lambda/lambdac) 2} 1 / 2 formulas, and dielectric dissipation factor lambda of a tandelta:dielectric : dielectricity -- wavelength lambdac in the living body : if it applies to the rectangular-waveguide (WRJ series) configuration by which cutoff-wavelength standardization was carried out -- {1-(lambda/lambdac) 2} 1/2 in an upper formula It is about 0.75.
[0028] Therefore, in order to carry out to below -100 (dB/m) that is the transmission loss with which practical use can be presented, it is required to choose a dielectric so that the following relation may be materialized.
[0029] f is frequency (GHz) to be used among fxepsilon r 1 / 2 xtandelta<=0.8 formula.
[0030] As such a dielectric substrate 1, there are alumina ceramics, a crystallized glass, alumimium nitride ceramics, etc., for example. The ceramic green sheet of two or more sheets is obtained by adopting a well-known doctor blade method, the well-known calendering-roll method, etc. conventionally, and making this with the shape of a sheet, while carrying out addition mixture of the suitable organic solvent and solvent for ceramic raw material powder and making it slurry-like. For example, after an appropriate time, While giving suitable punching processing for each of these ceramic green sheet, the laminating of these is carried out. In the case of alumina ceramics, in the case of 1500-1700 degrees C and a crystallized glass, it is manufactured by calcinating at the temperature of 1600-1900 degrees C in the case of 850-1000 degrees C and alumimium nitride ceramics.
[0031] Moreover, as it prints on a ceramic green sheet so that the transmission line may be completely covered for what carried out addition mixture of oxides, such as a suitable alumina silica magnesia for metal powders, such as a tungsten, the organic solvent, a solvent, etc. when the dielectric substrate 1 consisted of alumina ceramics as a conductor layer 2 of a couple, for example, and was made into the shape of a paste at least by the thick-film-screen-printing method, and it calcinates at the elevated temperature of after an appropriate time and about 1600 degrees C and it becomes the thickness of 10-15 micrometers or more In addition, in the case of a crystallized glass, in the case of alumimium nitride ceramics, as a metal powder, tungsten molybdenum is suitable for copper, gold, and silver. Moreover, generally thickness of a conductor layer 2 is set to about 5-50 micrometers.
[0032] moreover, penetration -- as a conductor 3 -- a beer hall -- a conductor and a through hole -- the cross-section configuration is [that what is necessary is just to form by the conductor etc.] also easy to manufacture -- it is circular and also you may be polygons, such as a rectangle and a rhombus these penetration -- the metal paste same to the breakthrough which pierced the conductor 3 for example, to the ceramic green sheet, processed, and was produced as the aforementioned conductor layer 2 -- embedding -- the after an appropriate time and dielectric substrate 1 -- simultaneously, it calcinates and forms in addition, penetration -- a conductor 3 -- diameters 50-300 mum is suitable.
[0033] Next, the plan same to drawing 3 as drawing 2 shows other examples of the form of operation of the dielectric-waveguide track of this invention.
[0034] It has a flection in a part of group 4. the penetration whose dielectric-waveguide track of this invention is the transmission line according to the structure shown in drawing 3 -- a conductor -- The group 4 is arranged. the width of face of the track which intersects perpendicularly in the transmission direction of a RF signal in a flection becomes almost the same as the fixed width of face d -- as -- penetration -- a conductor -- The conductor 3 is arranged and formed. the penetration located inside this flection -- a conductor -- one train of a group 4 -- drawing 2 -- the same -- one penetration -- the conductor 7 was made into the folding point -- breaking -- a line -- penetration -- the penetration located in the outside of a flection -- a conductor -- the train of another side of a group 4 -- this one penetration -- the shape of the polygonal line corresponding to base 8a of the isosceles triangle 8 which makes a conductor 7 a vertex and makes fixed width of face d height -- penetration -- it is characterized by arranging and forming the conductor 3
[0035] It can say that the example shown in drawing 3 is the configuration which omitted the angle of a flection aslant, and manufacture of a flection becomes easy as compared with the flection in the example shown in drawing 2 .

[0036] Next, the plan same to drawing 4 as drawing 2 and drawing 3 shows the example of further others of the form of operation of the dielectric-waveguide track of this invention.
[0037] It has a flection in a part of group 4. the penetration whose dielectric-waveguide track of this invention is the transmission line according to the structure shown in drawing 4 -- a conductor -- The group 4 is arranged. the width of face of the track which intersects perpendicularly in the transmission direction of a RF signal in a flection becomes almost the same as the fixed width of face d -- as -- penetration -- a conductor -- The conductor 3 is arranged and formed. the penetration located inside this flection -- a conductor -- a center [central point / where one train of a group 4 is imagination / 9 / of the inside this train was crooked] -- carrying out -- the predetermined radius r -- circular -- penetration -- the penetration located in the outside of a flection -- a conductor -- radius r+d of the train of another side of a group 4 which applied the fixed width of face d to the aforementioned radius r centering on this central point 9 is circular, i.e., an inside train and this heart, -- circular -- penetration -- by arranging and forming the conductor 3 penetration -- a conductor -- each train of the train of a group 4 is characterized by having the flection arranged by the concentric circle arc
[0038] Since the example shown in drawing 4 is formed in a configuration with smooth inside and outside of a flection, it has the advantage that disorder of electromagnetic field is very small, and transmission loss becomes small.
[0039]
[Example] About the dielectric-waveguide track of this invention of composition of having been shown in drawing 1 and drawing 2 , the transmission characteristic of the transmission line containing a flection was calculated with the finite element method. Conductivity uses the pure copper of 5.8x107 (1-/omegam) for the material of a conductor 3. a conductor layer 2 and penetration -- For specific inductive capacity, in the dielectric substrate 1, a dielectric dissipation factor is 0.001 at 5. The crystallized-glass sintered compact which calcinated and produced 75 % of the weight of way silica glasses and 25 % of the weight of aluminas is used. the thickness of a= 1mm of the dielectric substrate 1, and penetration -- the diameter of a conductor 3 -- 0.16mm and penetration -- a conductor -- the repeat interval of p= 1.58mm of a group 4, and penetration -- a conductor -- considering as fixed width of face of d= 2mm (WRJ-34 specification correspondence) of a group 4, the length of a track computed the frequency characteristic of an S parameter as 30mm
[0040] Consequently, it turns out that a cut off frequency is set to about 42GHz, and a signal penetrates good on the frequency beyond it. Moreover, at the outlet of a flection, it is the same electric-field distribution as an entrance, it was restricted only in the flection that a flection affects the distribution of field strength, and the distribution of field strength was not seen in the flection on the outside of the transmission line, therefore radiation of the electromagnetic wave in a flection was also understood that there is nothing.
[0041] Moreover, when the dielectric-waveguide track sample of the same composition was produced and the transmission characteristic was evaluated, the same good transmission characteristic as the above-mentioned calculation result was acquired.
[0042] Furthermore, when the transmission characteristic about the produced sample was similarly estimated as calculation by the finite element method about the dielectric-waveguide track of this invention of the structure shown in the drawing 3 row at drawing 4 , it has checked that all did not have radiation of the electromagnetic wave in a flection, and had a good transmission characteristic.
[0043]
[Effect of the Invention] according to [as explained in full detail above] the dielectric-waveguide track of this invention -- a dielectric substrate -- the conductor layer of a couple -- pinching -- the side attachment wall of a waveguide track -- penetration -- a conductor -- by forming by the group The conventional ceramic laminating technology can be applied and it can produce easily. moreover -- the composition of the flection prepared in a part of waveguide track -- penetration of two trains -- a conductor -- by having broken into the shape of the shape of the polygonal line, circular, or the polygonal line as mentioned above, and having formed the group in the line or the concentric circle arc Most transmission loss by radiation and disclosure of the electromagnetic wave in a flection could be

abolished, and the dielectric-waveguide track which has the good transmission characteristic of a RF signal was able to be offered.
[0044] Especially, by using ceramics with high specific inductive capacity for a dielectric substrate, it becomes a suitable thing for the multilayer-interconnection substrate of high-density wiring, the package for semiconductor device receipt, etc., and the waveguide track of the transmission characteristic stabilized by even the millimeter wave band from the microwave band can be formed.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is an outline perspective diagram for explaining the example of the gestalt of operation of the dielectric-waveguide track of this invention.
[Drawing 2] It is the plan of drawing 1 for explaining the example of the gestalt of operation of the dielectric-waveguide track of this invention.
[Drawing 3] It is the same plan as drawing 2 for explaining other examples of the gestalt of operation of the dielectric-waveguide track of this invention.
[Drawing 4] It is the same plan as drawing 2 for explaining the example of further others of the gestalt of operation of the dielectric-waveguide track of this invention.
[Description of Notations]
1 ..... Dielectric substrate
2 ..... Conductor layer
3 ..... penetration -- a conductor
4 ..... penetration -- a conductor -- a group
6 and 7...1 penetration -- a conductor (folding point)
8 ..... Isosceles triangle
8a .... Base

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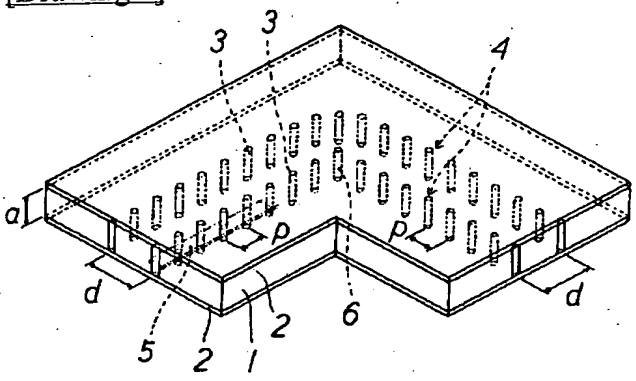
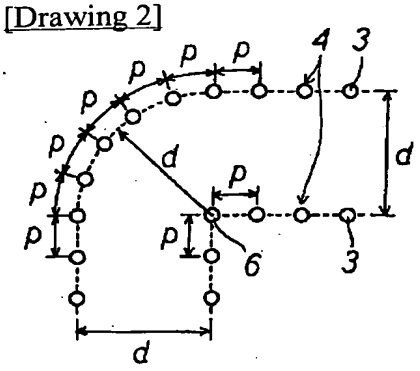
DRAWINGS

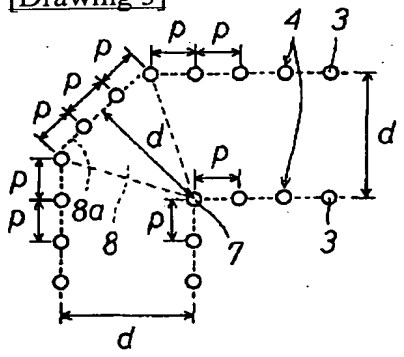
[Drawing 1]



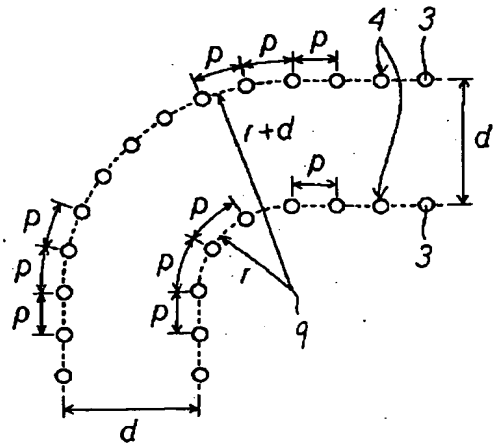
[Drawing 2]



[Drawing 3]



[Drawing 4]



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(71)出願人　000006633
京セラ株式会社
京都府京都市伏見区竹田鳥羽殿町6番地

(72)発明者　竹之下　健
鹿児島県国分市山下町1番4号　京セラ株式会社総合研究所内

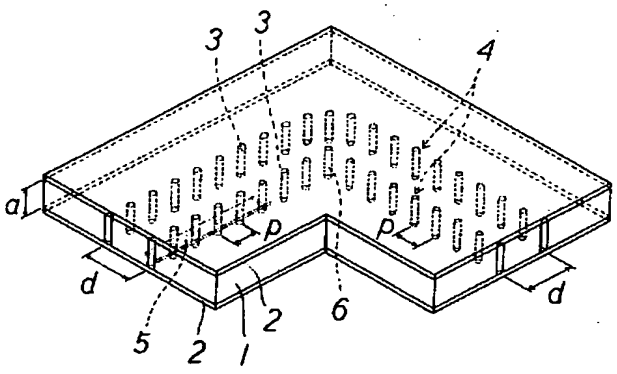
(72)発明者　内村　弘志
鹿児島県国分市山下町1番4号　京セラ株式会社総合研究所内

(54)【発明の名称】誘電体導波管線路

(57)【要約】

【課題】　従来の誘電体導波管線路では伝送線路中に屈曲部がある場合、屈曲部から電磁波の放射が起こり、高周波信号の伝送損失が大きくなる。

【解決手段】　誘電体基板１を挟持する一対の導体層２と、遮断波長の２分の１以下の繰り返し間隔ｐで、かつ一定の幅ｄで形成された２列の貫通導体群４とを具備し、２列の貫通導体群４がその一部に屈曲部を有し、屈曲部に位置する一方の列は１つの貫通導体６を屈曲点とした折れ線状に、他方の列は１つの貫通導体６を中心とし、一定の幅ｄを半径とする円弧状に形成されている誘電体導波管線路である。屈曲部における電磁波の放射がほとんど無く、高周波信号を低伝送損失で伝送できる。



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【特許請求の範囲】

【請求項１】　誘電体基板を挟持する一対の導体層と、高周波信号の伝送方向に前記高周波信号の遮断波長の２分の１以下の繰り返し間隔で、かつ前記伝送方向と直交する方向に一定の幅で前記導体層間を電気的に接続するよう形成された２列の貫通導体群とを具備し、前記導体層および前記貫通導体群に囲まれた領域によって高周波信号を伝送する誘電体導波管線路であって、前記２列の貫通導体群はその一部に屈曲部を有し、該屈曲部に位置する一方の列は１つの貫通導体を屈曲点とした折れ線状に形成されており、他方の列は前記１つの貫通導体を中心とし、前記一定の幅を半径とする円弧状に形成されていることを特徴とする誘電体導波管線路。

【請求項２】　誘電体基板を挟持する一対の導体層と、高周波信号の伝送方向に前記高周波信号の遮断波長の２分の１以下の繰り返し間隔で、かつ前記伝送方向と直交する方向に一定の幅で前記導体層間を電気的に接続するよう形成された２列の貫通導体群とを具備し、前記導体層および前記貫通導体群に囲まれた領域によって高周波信号を伝送する誘電体導波管線路であって、前記２列の貫通導体群はその一部に屈曲部を有し、該屈曲部に位置する一方の列は１つの貫通導体を屈曲点とした折れ線状に形成されており、他方の列は前記一方の列の前記屈曲点を頂点とし前記一定の幅を高さとする二等辺三角形の底辺に対応する折れ線状に形成されていることを特徴とする誘電体導波管線路。

【請求項３】　誘電体基板を挟持する一対の導体層と、高周波信号の伝送方向に前記高周波信号の遮断波長の２分の１以下の繰り返し間隔で、かつ前記伝送方向と直交する方向に一定の幅で前記導体層間を電気的に接続するよう形成された２列の貫通導体群とを具備し、前記導体層および前記貫通導体群に囲まれた領域によって高周波信号を伝送する誘電体導波管線路であって、前記２列の貫通導体群は、その各列が同心円弧状に配列された屈曲部を有することを特徴とする誘電体導波管線路。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、マイクロ波帯やミリ波帯等の高周波信号を伝達するための誘電体導波管線路に関するものである。

【０００２】

【従来技術】マイクロ波帯やミリ波帯等の高周波信号を扱う高周波回路において高周波信号を伝送するための伝送線路には小型で伝送損失が小さいことが求められており、特に回路を構成する基板上または基板内に形成できると小型化の面で有利となることから、従来、そのような伝送線路としてストリップ線路やマイクロストリップ線路・コプレナ線路・誘電体導波管線路などが用いられてきた。

【０００３】これらのうちストリップ線路・マイクロストリップ線路・コプレナ線路は誘電体基板と導体層から成る信号線路とグランド導体層とで構成されており、信号線路とグランド導体層の周囲の空間および誘電体中を高周波信号の電磁波が伝播するものであるが、これらの線路は30ＧＨｚ帯域までの信号伝送に対しては問題ないが、30ＧＨｚ以上では伝送損失が生じやすい。

【０００４】これに対して導波管型の線路は30ＧＨｚ以上のミリ波帯域においても伝送損失が小さい点で有利であり、このような導波管の優れた伝送特性を活かし、多層基板内に形成可能な線路も提案されている。

【０００５】例えば特開平６－53711 号公報において、誘電体基板を一対の導体層で挟み、さらに導体層間を接続する２列の複数のビアホールによって側壁を形成した導波管線路が提案されている。この導波管線路によれば、誘電体材料の四方を導体層とビアホールによる疑似的な導体壁で囲むことによって導体壁内の領域を信号伝送用の線路としたものであり、構成がいたって簡単となって装置全体の小型化も図り得るというものである。

【０００６】

【発明が解決しようとする課題】一般に、高周波回路を構成する場合、伝送線路の配線回路において屈曲部を設けることが避けられないことが多い。

【０００７】ところが、特開平６－53711 号公報に提案されたような誘電体導波管線路において、その一対の導体層と２列のビアホールによる疑似的な導体壁で囲まれた信号伝送用の線路に単純に屈曲部を設けた場合、電磁界に乱れが生じることから、伝送損失が大きくなるという問題点があった。

【０００８】本発明は上記事情に鑑みて案出されたものであり、その目的は、伝送線路に屈曲部が存在しても高周波信号の電磁波の放射・漏洩が無く、伝送損失が小さい良好な伝送特性を有する誘電体導波管線路を提供することにある。

【０００９】

【課題を解決するための手段】本発明者等は、上記の問題点に対して検討を重ねた結果、誘電体導波管線路について、誘電体基板中に設けた２列のビアホール群の上下をこれらビアホール群と電気的に導通した一対の導体層で完全に覆って形成される構造の伝送線路に設けた屈曲部において２列のビアホール群のビアホールの配列を所定の配列構造とすることにより、伝送線路に屈曲部が存在しても高周波信号の電磁波の放射・漏洩がほとんど無く、低伝送損失の良好な伝送特性とできることを見いだした。

【００１０】本発明の誘電体導波管線路は、誘電体基板を挟持する一対の導体層と、高周波信号の伝送方向に前記高周波信号の遮断波長の２分の１以下の繰り返し間隔で、かつ前記伝送方向と直交する方向に一定の幅で前記導体層間を電気的に接続するよう形成された２列の貫通導体群とを具備し、前記導体層および前記貫通導体群に

囲まれた領域によって高周波信号を伝送する誘電体導波管線路であって、前記２列の貫通導体群はその一部に屈曲部を有し、この屈曲部に位置する一方の列は１つの貫通導体を屈曲点とした折れ線状に形成されており、他方の列は前記１つの貫通導体を中心とし、前記一定の幅を半径とする円弧状に形成されていることを特徴とするものである。

【００１１】また、本発明の誘電体導波管線路は、誘電体基板を挟持する一対の導体層と、高周波信号の伝送方向に前記高周波信号の遮断波長の２分の１以下の繰り返し間隔で、かつ前記伝送方向と直交する方向に一定の幅で前記導体層間を電気的に接続するよう形成された２列の貫通導体群とを具備し、前記導体層および前記貫通導体群に囲まれた領域によって高周波信号を伝送する誘電体導波管線路であって、前記２列の貫通導体群はその一部に屈曲部を有し、この屈曲部に位置する一方の列は１つの貫通導体を屈曲点とした折れ線状に形成されており、他方の列は前記一方の列の前記屈曲点を頂点とし前記一定の幅を高さとする二等辺三角形の底辺に対応する折れ線状に形成されていることを特徴とするものである。

【００１２】また、本発明の誘電体導波管線路は、誘電体基板を挟持する一対の導体層と、高周波信号の伝送方向に前記高周波信号の遮断波長の２分の１以下の繰り返し間隔で、かつ前記伝送方向と直交する方向に一定の幅で前記導体層間を電気的に接続するよう形成された２列の貫通導体群とを具備し、前記導体層および前記貫通導体群に囲まれた領域によって高周波信号を伝送する誘電体導波管線路であって、前記２列の貫通導体群は、その各列が同心円弧状に配列された屈曲部を有することを特徴とするものである。

【００１３】本発明の誘電体導波管線路によれば、誘電体基板を挟持する一対の導体層と、高周波信号の伝送方向に前記高周波信号の遮断波長の２分の１以下の繰り返し間隔で、かつ前記伝送方向と直交する方向に一定の幅で前記導体層間を電気的に接続するよう形成された２列の貫通導体群とを具備することから、これら導体層と貫通導体群がそれぞれ誘電体導波管のＥ面とＨ面もしくはＨ面とＥ面に平行な疑似的な導体壁にあたる部分を形成する。従って、誘電体基板を用いた平板構造で誘電体導波管に類似した特性を有する高周波信号用の伝送線路を得られる。

【００１４】そして、本発明の誘電体導波管線路によれば、伝送線路の配線において屈曲部を設けるに際し、２列の貫通導体群を前記特定構造に配列することにより、屈曲部における電磁波の放射がほとんど無く、伝送損失が小さく良好な伝送特性を有するものとなる。

【００１５】

【発明の実施の形態】以下、本発明を図面を参照しながら説明する。図１および図２は、それぞれ本発明の誘電体導波管線路の実施の形態の一例を説明するための概略斜視図およびその平面図である。これらの図において、１は誘電体基板、２は誘電体基板１を挟持する一対の導体層、３は一対の導体層２間を電気的に接続するよう形成された貫通導体であり、４は高周波信号の伝送方向にその高周波信号の遮断波長の２分の１以下の繰り返し間隔ｐで、かつその伝送方向と直交する方向に一定の幅ｄで貫通導体３を配設することにより形成された２列の貫通導体群である。

【００１６】図１によれば、所定の厚みａの平板状の誘電体基板１を挟持する位置に一対の導体層２・２が形成されている。導体層２・２は誘電体基板１の少なくとも伝送線路形成位置を挟む上下面に形成されている。また、導体層２・２間には導体層２・２間を電気的に接続する貫通導体３が多数設けられている。これら貫通導体３は、図１および図２に示すように、高周波信号の伝送方向すなわち線路形成方向にこの線路により伝送される高周波信号の遮断波長の２分の１以下の所定の繰り返し間隔ｐで、かつ前記伝送方向と直交する方向に所定の一定の間隔（幅）ｄをもって２列に形成されることにより、伝送線路となる貫通導体群４を形成している。

【００１７】平行に配置された一対の導体層２・２間にはＴＥＭ波が伝播できるため、貫通導体群４の各列における貫通導体３の間隔ｐが遮断波長の２分の１よりも大きいと、この線路に電磁波を給電してもここで作られる疑似的な導波管に沿って伝播しなくなる。しかし、貫通導体３の間隔ｐが遮断波長の２分の１以下であると電気的な側壁を形成することとなって、電磁波は伝送線路に対して垂直方向に伝播することができず、反射しながら伝送線路方向に伝播されることとなる。その結果、このような構造の導体層２と貫通導体群４とにより囲まれる断面積がａ×ｄのサイズの領域により誘電体導波管と非常に良く類似した良好な伝送特性が得られる。

【００１８】ここで、誘電体基板１の厚みａに対する制限は特にないが、シングルモードで用いる場合には前記一定の幅ｄに対して２分の１程度または２倍程度とすることがよく、図１の例では誘電体導波管のＨ面とＥ面に当たる部分が各々導体層２と貫通導体群４で形成され、幅ｄに対して厚みａを２倍程度とすれば、誘電体導波管のＥ面とＨ面に当たる部分が各々導体層２と貫通導体群４で形成されることとなる。

【００１９】なお、５は貫通導体群４の各列を形成する貫通導体３同士を電気的に接続する補助導体層であり、所望により適宜形成される。また、この図１および図２の例では貫通導体群４は２列に形成したが、この貫通導体群４を４列あるいは６列に配設して貫通導体群４による疑似的な導体壁を２重・３重に形成することにより、導体壁からの電磁波の漏れをより効果的に防止することもできる。

【００２０】このような導波管線路構造によれば、誘電

体基板１の比誘電率をε_rとすると導波管サイズは通常の導波管の$1/\varepsilon_r^{1/2}$の大きさになる。従って、誘電体基板１を構成する材料を比誘電率の大きいものとするほど、導波管サイズを小さくすることができ、高密度に配線が形成される多層配線基板または半導体素子収納用パッケージの伝送線路として利用可能な大きさとなる。

【００２１】また、図１および図２に示すように、本発明の誘電体導波管線路はその伝送線路である貫通導体群４の一部に屈曲部を有し、この屈曲部の内側に位置する一方の列は１つの貫通導体６を屈曲点とした折れ線状に形成されており、外側に位置する他方の列はこの１つの貫通導体６を中心とする円弧状に形成されていることを特徴とするものである。そのような屈曲部は、例えば図２に示すような構造で構成される。

【００２２】図２に記載される通り、屈曲部においては高周波信号の伝送方向に直交する線路の幅が一定の幅ｄとなるように貫通導体群４が配置されており、屈曲部の内側に位置する貫通導体群４の列は１つの貫通導体６を屈曲点とした折れ線状となるように貫通導体３が配設され、他方、屈曲部の外側に位置する貫通導体群４の列は屈曲部の内側にあたる列の屈曲点である１つの貫通導体６を中心として半径ｄの円弧を描くように配置される。

【００２３】なお、貫通導体群４を構成する貫通導体３は前述のように遮断波長の２分の１以下の繰り返し間隔ｐで配設されており、この繰り返し間隔ｐは良好な伝送特性を実現するためには一定の繰り返し間隔とすることが望ましいが、遮断波長の２分の１以下の間隔であれば適宜変化させたりいくつかの値を組み合わせたりしてもよいことは言うまでもない。従って、屈曲部の外側にあたる貫通導体群４の列を構成する貫通導体３の繰り返し間隔ｐも、電磁波の放射を十分に抑制して良好な伝送特性を実現するためには一定の値とすることが望ましいが、同様に遮断波長の２分の１以下の値で種々変化させてもよいものである。

【００２４】本発明における誘電体基板１としては、誘電体として機能し高周波信号の伝送を妨げることのない特性を有するものであればとりわけ限定するものではないが、伝送線路を形成する際の精度および製造の容易性の点からは、誘電体基板１はセラミックスからなることが望ましい。

【００２５】このようなセラミックスとしてはこれまで様々な比誘電率を持つセラミックスが知られているが、本発明の導波管線路によって高周波信号を伝送するためには常誘電体であることが望ましい。これは、一般に強誘電体セラミックスは高周波領域では誘電損失が大きく伝送損失が大きくなるためである。従って、誘電体基板１の比誘電率ε_rは４～100 程度が適当である。

【００２６】また、一般に多層配線基板や半導体素子収納用パッケージに形成される配線層の線幅は最大でも１ｍｍであることから、比誘電率が100 の材料を用い、上部がＨ面すなわち磁界が上側の面に平行に巻く電磁界分布になるように用いた場合、用いることのできる最小の周波数は15ＧＨｚと算出され、マイクロ波帯の領域でも利用可能となる。一方、一般的に誘電体基板１として用いられる樹脂からなる誘電体は、比誘電率ε_rが２程度であるため、線幅が１ｍｍの場合、約100 ＧＨｚ以上でないと利用することができないものとなる。

【００２７】また、このような常誘電体セラミックスの中にはアルミナ・シリカ等のように誘電正接が非常に小さなものが多いが、全ての常誘電体セラミックスが利用可能であるわけではない。誘電体導波管線路の場合は導体による損失はほとんどなく、信号伝送時の損失のほとんどは誘電体による損失であり、誘電体による損失α（ｄＢ／ｍ）は下記のように表わされる。

$$\alpha = 27.3 \times \tan\delta / \lambda / |1 - (\lambda/\lambda c)^2|^{1/2}$$

式中、$\tan\delta$：誘電体の誘電正接

λ　　：誘電体中の波長

λc　　：遮断波長

規格化された矩形導波管（ＷＲＪシリーズ）形状に準ずると、上式中の$|1 - (\lambda/\lambda c)^2|^{1/2}$は0.75程度である。

【００２８】従って、実用に供し得る伝送損失である－100 （ｄＢ／ｍ）以下にするには、下記の関係が成立するように誘電体を選択することが必要である。

【００２９】$f \times \varepsilon_r^{1/2} \times \tan\delta \leqq 0.8$

式中、ｆは使用する周波数（ＧＨｚ）である。

【００３０】このような誘電体基板１としては、例えばアルミナセラミックスやガラスセラミックス・窒化アルミニウムセラミックス等があり、例えばセラミックス原料粉末に適当な有機溶剤・溶媒を添加混合して泥漿状になすとともにこれを従来周知のドクターブレード法やカレンダーロール法等を採用してシート状となすことによって複数枚のセラミックグリーンシートを得、しかる後、これらセラミックグリーンシートの各々に適当な打ち抜き加工を施すとともにこれらを積層し、アルミナセラミックスの場合は1500～1700℃、ガラスセラミックスの場合は850 ～1000℃、窒化アルミニウムセラミックスの場合は1600～1900℃の温度で焼成することによって製作される。

【００３１】また、一対の導体層２としては、例えば誘電体基板１がアルミナセラミックスから成る場合、タングステン等の金属粉末に適当なアルミナ・シリカ・マグネシア等の酸化物や有機溶剤・溶媒等を添加混合してペースト状にしたものを厚膜印刷法により少なくとも伝送線路を完全に覆うようにセラミックグリーンシート上に印刷し、しかる後、約1600℃の高温で焼成し、厚み10～15μｍ以上となるようにして形成する。なお、金属粉末としては、ガラスセラミックスの場合は銅・金・銀が、窒化アルミニウムセラミックスの場合はタングステン・モリブデンが好適である。また、導体層２の厚みは一般

的に５～50μｍ程度とされる。

【００３２】また、貫通導体３としては、例えばビアホール導体やスルーホール導体等により形成すればよく、その断面形状も製作が容易な円形の他、矩形や菱形等の多角形であってもよい。これら貫通導体３は、例えばセラミックグリーンシートに打ち抜き加工を施して作製した貫通孔に前記導体層２と同様の金属ペーストを埋め込み、しかる後、誘電体基板１と同時に焼成し形成する。なお、貫通導体３は直径50～300 μｍが適当である。

【００３３】次に、本発明の誘電体導波管線路の実施の形態の他の例を図３に図２と同様の平面図で示す。

【００３４】図３に示す構造によれば、本発明の誘電体導波管線路はその伝送線路である貫通導体群４の一部に屈曲部を有し、屈曲部においては高周波信号の伝送方向に直交する線路の幅が一定の幅ｄとほぼ同じとなるように貫通導体群４が配置されており、この屈曲部の内側に位置する貫通導体群４の一方の列は図２と同様に１つの貫通導体７を屈曲点とした折れ線状に貫通導体３が配設されて形成されており、屈曲部の外側に位置する貫通導体群４の他方の列はこの１つの貫通導体７を頂点とし一定の幅ｄを高さとする二等辺三角形８の底辺８ａに対応する折れ線状に貫通導体３が配設されて形成されていることを特徴とするものである。

【００３５】図３に示す例は屈曲部の角を斜めにカットした形状であると言え、図２に示した例における屈曲部に比較して、屈曲部の製作が容易になるものである。

【００３６】次に、本発明の誘電体導波管線路の実施の形態のさらに他の例を図４に図２・図３と同様の平面図で示す。

【００３７】図４に示す構造によれば、本発明の誘電体導波管線路はその伝送線路である貫通導体群４の一部に屈曲部を有し、屈曲部においては高周波信号の伝送方向に直交する線路の幅が一定の幅ｄとほぼ同じとなるように貫通導体群４が配置されており、この屈曲部の内側に位置する貫通導体群４の一方の列はこの列の屈曲した内側の仮想的な中心点９を中心とし所定の半径ｒの円弧状に貫通導体３が配設されて形成されており、屈曲部の外側に位置する貫通導体群４の他方の列はこの中心点９を中心とし前記半径ｒに一定の幅ｄを加えた半径ｒ＋ｄの円弧状すなわち内側の列と同心の円弧状に貫通導体３が配設されて形成されていることによって、貫通導体群４の列の各列が同心円弧状に配列された屈曲部を有していることを特徴とするものである。

【００３８】図４に示す例は屈曲部の内側・外側共に滑らかな形状に形成されるため、電磁界の乱れが非常に小さく、伝送損失が小さくなるという利点を有する。

【００３９】

【実施例】図１および図２に示した構成の本発明の誘電体導波管線路について、屈曲部を含む伝送線路の伝送特性を有限要素法により計算した。導体層２および貫通導体３の材料には導電率が5.8 ×10^7 （１／Ωｍ）の純銅を用い、誘電体基板１には比誘電率が５で誘電正接が0.001 の、ほう珪酸ガラス75重量％とアルミナ25重量％とを焼成して作製したガラスセラミックス焼結体を用い、誘電体基板１の厚みａ＝１ｍｍ、貫通導体３の直径を0.16ｍｍ、貫通導体群４の繰り返し間隔ｐ＝1.58ｍｍ、貫通導体群４の一定の幅ｄ＝２ｍｍ（ＷＲＪ－34規格対応）とし、線路の長さは30ｍｍとしてＳパラメータの周波数特性を算出した。

【００４０】その結果、遮断周波数は約42ＧＨｚとなり、それ以上の周波数では信号が良好に透過することが分かった。また、屈曲部の出口では入口と同様な電界分布になっており、屈曲部が電界強度の分布に影響を与えるのは屈曲部内のみに限られ、屈曲部において伝送線路の外側に電界強度の分布は見られず、従って、屈曲部における電磁波の放射は無いことも分かった。

【００４１】また、同様の構成の誘電体導波管線路試料を作製してその伝送特性を評価したところ、上記算出結果と同様の良好な伝送特性が得られた。

【００４２】さらに、図３ならびに図４に示した構造の本発明の誘電体導波管線路についても同様に有限要素法による計算と作製した試料についての伝送特性の評価を行なったところ、いずれも屈曲部における電磁波の放射が無く良好な伝送特性を有することが確認できた。

【００４３】

【発明の効果】以上詳述した通り、本発明の誘電体導波管線路によれば、誘電体基板を一対の導体層で挟持し、導波管線路の側壁を貫通導体群により形成することによって、従来のセラミックス積層技術を応用して容易に作製することができ、また、導波管線路の一部に設ける屈曲部の構成について、２列の貫通導体群を前述のように折れ線状と円弧状、あるいは折れ線状と折れ線状、あるいは同心円弧状に形成したことによって、屈曲部における電磁波の放射・漏洩による伝送損失をほとんど無くすることができ、高周波信号の良好な伝送特性を有する誘電体導波管線路を提供することができた。

【００４４】中でも、誘電体基板に比誘電率の高いセラミックスを用いることによって、高密度配線の多層配線基板や半導体素子収納用パッケージ等に好適なものとなり、マイクロ波帯からミリ波帯まで安定した伝送特性の導波管線路を形成することができる。

【図面の簡単な説明】

【図１】本発明の誘電体導波管線路の実施の形態の例を説明するための概略斜視図である。

【図２】本発明の誘電体導波管線路の実施の形態の例を説明するための図１の平面図である。

【図３】本発明の誘電体導波管線路の実施の形態の他の例を説明するための図２と同様の平面図である。

【図４】本発明の誘電体導波管線路の実施の形態のさらに他の例を説明するための図２と同様の平面図である。

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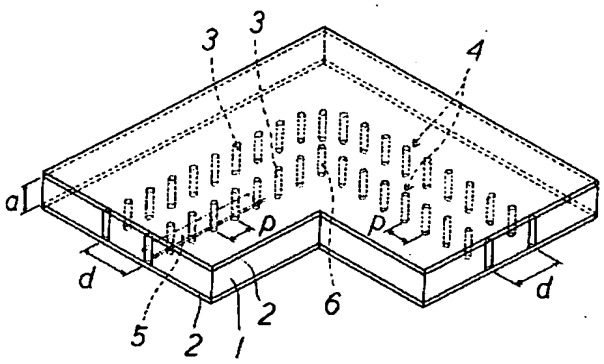
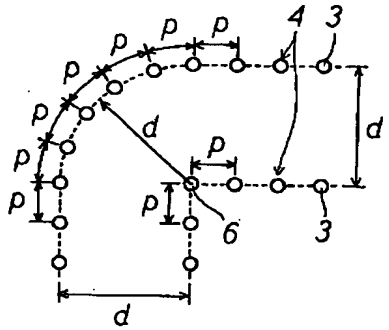
【符号の説明】

1・・・・・誘電体基板
2・・・・・導体層
3・・・・・貫通導体
4・・・・・貫通導体群
6、７・・・１つの貫通導体（屈曲点）
8・・・・・二等辺三角形
8ａ・・・・底辺

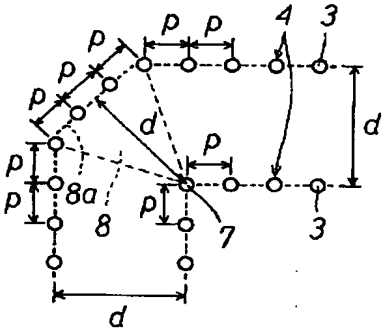
【図１】



【図２】



【図３】



【図４】